WHAT IS CLAIMED IS:

1. A method of approximating an FIR filter with low-order linear-phase IIR filters by the rational Arnoldi algorithm with adaptive orders containing the following steps:a. initialize the first vector of the Krylov sequence for each expansion point;

b. in the jth iteration of the algorithm, choosing an expansion frequency such that the frequency gives the greatest difference between the (j+1)st-order output moment of the original FIR filter $H(z)$ and that of the lower-order IIR filter $\hat{H}(z)$;c. after the choosing the expansion point in jth iteration being determined, the single-point Arnoldi method applied at the expansion point to generate the new orthnormal vector; and

d. determine a new residual at each expansion point for next iteration;

whereby, after the giving total iteration number of the algorithm, outputting the resulting orthogonal projection matrix.

2. The method as claimed in claim 1, wherein the exact expression of output moment errors between the $\hat{j}_i$ th-order moments $H^{(\hat{j}_i)}(z_i)$ and $\hat{H}^{(\hat{j}_i)}(z_i)$ at each expansion point z_i are expressed as follows:

$$|H^{(\hat{j}_i)}(z_i) - \hat{H}^{(\hat{j}_i)}(z_i)| = |h_\pi c^T r^{(\hat{j}_i - 1)}(z_i)|,$$

where

$h_\pi(z_i) = \prod_j \left\| r^{(j-1)}(z_i) \right\|$ is the normalization coefficient when an expansion frequency z_i is selected in the jth iteration;

vector c contains the last n impulse response coefficients of a FIR filter with

length $n+1$; and

$r^{(j-1)}(z_i)$ is the residual vector in the (j-1)st iteration of the disclosed adaptive rational Arnoldi algorithm at the expansion frequency z_i.

3. The method as claimed in claim 1, wherein the heuristics of selecting expansion frequencies in advance for the proposed rational Arnoldi method are given by

(a) low-pass filters: the proposed method with the expansion point $\omega_1 = 0$;

(b) high-pass filters: the special structures of state-space matrices used to present the duality between low-pass and high-pass filters; let state matrices become $\overline{A} = -A$, $\overline{b} = b$, $\overline{c} = c$, and $\overline{h_0} = -h_0$, the expansion point $\omega_1 = 0$ chosen to perform the Arnoldi algorithm; when the corresponding orthonormal matrix $\overline{V}_q$ is obtained and then the high-pass IIR filter, which satisfies the same specifications as the original FIR filter; and

(c) band-pass/band-stop filters: the passband edge and the stopband edge frequenciesbeing the appropriate candidate expansion points in meeting the specifications of the design, and other expansion points with uniform spacing being recommend to be selected.